Digital Simulations and Digital Video Games in the Science Classroom

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Introduction

As technology continues to change the landscape of education it is important that all educators utilize the benefits they present. Digital simulations and video games are uses of technology that present opportunities to increase student engagement, accommodate learners and bring new experiences to schools globally.

Digital simulations are computer-based tools used to represent course content digitally within the classroom. There are many types, including laboratory simulations, learning and training simulations, and digital video games (DVGs). DVGs are a type of simulation used in the classroom to teach curriculum concepts, in addition to technological literacy, science, technology, engineers and mathematics (STEM) education, 21st century skills and interdisciplinary learning (DeCoito & Briona, 2020). Using "serious games", which have a greater purpose than purely entertainment, we as educators can provide an engaging way to teach material to students (Becker & Parker, 2006). Through the active engagement required of DVGs, students are academically challenged, engage in cooperative learning, and develop problem solving strategies (Gros, 2007); skills that are not readily learned through "textbook learning". Despite the value DVGs present to enrich the educational experience, very few educators utilize them within their own classrooms (DeCoito & Richardson, 2015), potentially due to lack of understanding. The objective of this article is to elucidate how digital simulations and DVGs can improve students' educational experiences and be effectively implemented in the classroom.

Applications in the Science Classroom

Digital simulations can be used in the classroom for a variety of purposes, including preparation for laboratory experiments, as a substitute for real-life lab experiments, and to

provide lab and field experiences normally not possible in the traditional classroom. Substitutes for lab experiments can include virtual dissections and experiments (Table 1). These digital simulations are an alternative approach that can be used for students who are unable or unwilling to participate in real life labs. Teachers can also use these digital labs to prepare students for laboratory procedures and safety guidelines prior to conducting a real-life lab, thus minimizing any confusion that may occur on lab days. In addition, digital simulations can be used to emulate field experiences. These digital simulations provide students with an experience that would be difficult to obtain in the classroom and are currently unattainable for them, despite the COVID-19 pandemic. Educators can use digital simulations to engage students by providing opportunities for them to expand, collaborate and reflect on their learning in a student-centered environment (Vlachopoloulos & Makri, 2017).

The use of DVGs, a type of digital simulation, can also provide enriched learning when incorporated in the classroom. From elementary engineering with bridge builder games, to high level physics with Kerbal Space Program (Table 2), DVGs can teach course content in an engaging manner, for students at any grade level. Teachers can use the same DVG to teach varying levels of subject knowledge. This can be seen within Minecraft Education Edition (Table 2), where students can learn content from basic algebra to high school level probability.

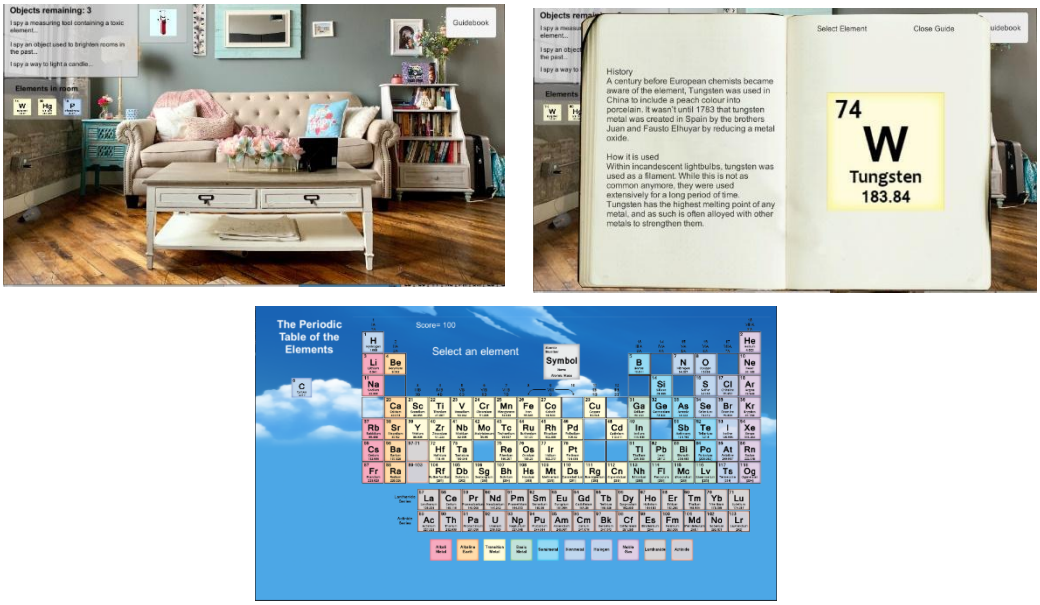
Additionally, DVGs can focus on rapid visual stimuli, develop stories for students to follow, and provide challenges for students to overcome (Dowell, 2007). DVGs help students develop critical thinking and problem-solving skills and help them grow as globally minded thinkers. It is for these reasons that DVGs are an important medium for engaging students in learning, resulting not only in knowledge construction and understanding, but development of soft skills that will help students succeed in the future.

Periodic Table Scavenger Hunt Game

As a component of my STEM specialization within my Bachelor of Education degree at Western University, I created a periodic table DVG centered around the grade 9 applied and academic chemistry curriculum (Figure 1). My objectives with this project were for students to understand the wide historical and cultural significance of common household elements and learn how to place them on the periodic table (Grade 9 chemistry, objective C3). This way, students could potentially broaden their world view in a fun and engaging setting. My DVG specifically addresses STEM learning by helping students understand the practical applications of grade 9 chemistry content and highlighting the presence of chemistry in their every day lives. In addition, students develop technological literacy skills by using DVGs as they are presented in a digital medium. This is especially important for the development of students as future STEM leaders, who will engage within both interdisciplinary work and the digital landscape in their future careers. Thus, DVGs can be an effective approach for educators to foster STEM learning, 21st century skills and global citizenship in our students.

Figure 1

Screencaps from "Periodic Table Scavenger Hunt" game



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Note: Students search for elements within a scavenger hunt style room. Cultural context and hints are provided within the guidebook provided on the top right of the screen. After clearing a room, students can place the elements they have discovered on the periodic table of elements

Safety

When engaging with digital games and simulations, it is important that students and teachers practice online safety. Before engaging in any online or digital activity, teachers should review the importance of protecting private information online with their students, and the consequences of cyberbullying. In addition, digital literacy and the critical analysis of digital media should be explored with students prior to DVG or simulation use (MediaSmarts, 2019). As students engage in the online world through use of games and simulations, it is important they can effectively navigate the Internet and evaluate digital sources for reliability and accuracy (MediaSmarts, 2019).

Suggestions for Digital Simulations and Games for Classroom Use

Table 1

Outline of various digital simulations that can be incorporated into the classroom.

Simulation	Description	Curriculum Connections
YouTube VR	YouTube provides a multitude of free virtual reality videos students can explore using computers or hand-held devices. This allows students to experience NASA's Mars rover, the world through a bird's eyes and other unattainable experiences.	All K-12 Science courses
Population Dynamics Simulator	Population dynamics simulators are excellent for intermediate and senior students to examine the relationship between a variety of organisms in a food web. Students learn to model populations overtime using graphs.	Ecosystems and carrying capacity: - SNC1D B3.3
Frog Dissection Lab	Virtual dissection labs enable students to examine the organs of an animal virtually. This provides opportunities for students who are unable to or choose not to partake in real life dissection labs.	Dissection Labs: - SNC2D B2.6 - SNC2P B2.5
NOVA Labs	A collection of digital simulations by PBS that teach science concepts from evolution to energy in a fun, visually pleasing format.	The Sun - SNC1D D3.4 - SNC1P D2.2 Evolution - SBI3U Strand C - SBI4U D3.2 - SNC4M F3.2

Table 2

Outline of various digital simulations that can be incorporated into the classroom.

Digital video game	Explanation	Curriculum Connections
History of Biology	An online scavenger-hunt style game where students delve into the history of prominent biologists. Students walk through a story-oriented game and participate in a variety of engaging games and activities.	History of Science - SBI3U C2.3 - A2.2 of all senior biology courses
Minecraft Education Edition	Minecraft Education edition allows students to engage in an immersive world where they can build creations or run through games created by their teacher. It has applications in every subject area, including full 3D cell environments, engineering projects, engaging mathematics activities and all manners of cooperative work.	All K-12 Science courses
Kerbal Space Program	Kerbal Space Program provides students with an in-depth look at the space program. Students can use its physics engine to emulate space launches using realistic physics and mathematics.	Rocket physics - SPH4U C1.1 - SPH4U F2.3
PBS Kids Games	PBS kids' games provide a variety of fun games for students at the elementary level. Teachers can use this website to introduce concepts such as space, art, and environmentalism to students in a fun-engaging manner.	All K-8 Science courses

Digital simulations and DVGs are an effective way to teach curriculum content while instilling 21st century skills and global citizenship in a student-centered learning environment. With the resources highlighted, teachers can begin exploring digital simulations within their own classrooms to enrich student learning. The next steps for educators is to begin implementing digital simulations and DVGs into practice, as they have the potential to positively change the landscape of education.

References

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